Design of an experimental set-up for the measurement of LET distributions

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RADiation and Reliability Challenges for Electronics used in Space, Aviation, Ground and Accelerators (RADSAGA) is a project funded by the European Commission under the Horizon2020 Framework Program under the Grant Agreement 721624. RADSAGA began in Mars 2017 and will run for 5 years.
Presentation outline

- Project outline
- Detectors
- Design of the experimental set-up
- Construction
- Summary and outlook
Project

- Measurement and simulation of LET distributions
  - Linear energy transfer: \( LET = \frac{dE}{dx} \)
  - Geant4 and Fluka

- Comparison of different types of thin semiconductor detectors
  - Increased accuracy with thinner geometries
  - Measurement of non-primary particles

- Relation of LET to SEE rates
Clinical relevance

- High dose area is not necessarily an area of high LET
Detectors

- **Measurement of LET distributions:**
  - Silicon detector:
    - 3D Mushroom detector (CMRP)
    - $d = 10 \, \mu m$
  - Diamond detector:
    - PTW microDiamond
    - $d = 1 \, \mu m$
Detectors

- **Measurement of SEU: ESA SEU monitor**
  - Reference monitor for SEU measurements
  - Different test patterns can be loaded
Design of the experimental set-up

- **Proposed experiments:**
  - **Measurement of LET distributions:**
    - Determination of applicability of Mushroom and microDiamond detector
    - Measurement in proton and heavy ion beams up to Bi in vacuum
  - **Measurement of SEEs:**
    - Special attention paid to sub-LET-threshold SEEs
    - Measurement with various thin foils in front of the detector
      - non-semiconductor materials found in chips, e.g. W
Design of the experimental set-up

- Measurement under vacuum conditions

- Requirements for the vacuum chamber:
  - Contain all detectors
  - Make image of the beam
  - Calibration
  - Flux determination
  - Heavy ion and proton measurements
  - Operation at different institutes
Component set-up

- Detectors (mD, ESA, mushroom)
- Collimators
- Target ladder
- Edge detectors
- Scionix detector and Lanex screen
- Entrance window

Beam direction

Camera

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Field-edge detectors

- Four Scionix scintillation detectors with photomultiplier tubes
Target ladder

- Possibility to insert three different thin foils
- Connection to stepper motor
Stand-alone system

- Independent vacuum
- Connection to vacuum pipe at KVI possible
- Support frame with 40 cm height
- Entrance and exit foil
Construction progress
Construction progress
Summary and outlook

- Design of the vacuum chamber is completed
- Construction takes place at the moment
- A few mechanical problems have to be sorted out
- Experiments at KVI can hopefully start in late summer/autumn
- Vacuum chamber has an independent vacuum for use at other institutes
- Modify the set-up for use at different institutes
Bibliography


[3] PTW Freiburg, MicroDiamond Detector, Brochure, accessed: 03.03.2020